

JP-09-005762E

[Title of the Invention]      METHOD FOR PRODUCING LIQUID  
CRYSTAL PANEL

[Abstract]

[Object] There is provided a method for producing liquid crystal panel that prevents the occurrence of the unequal display in a panel surface that is caused by the influence of various kinds of impurities existing in an atmosphere for producing a liquid crystal panel.

[Solving Means] The bonding speed at the time of holding liquid crystals 8 by a dropping method between two sheets of glass substrates 1 and 2 subjected to orientation treatments on transparent electrode patterns 3, 4 is made sufficiently gentle and the liquid crystals are held at a temperature above the transparent point of the liquid crystals. The liquid crystal panel in which the impurities existing in the liquid crystals or on the substrates do not exist macroscopically unequally within the panel surface and the unequal display does not arise is produced by suppressing the influence of the external energy that the liquid crystals receive at the time of dispersing on the substrates.

## [Claims]

[Claim 1] A method for producing liquid crystal panel in which the liquid crystal panel is made by sandwiching a liquid crystal between two pieces of substrates by means of a liquid crystal dropping method, wherein the electrode patterns of the two pieces of substrates are subjected to an orientation treatment, wherein in the bonding process of the substrates is characterizing: the occurrence of the unequal display that are related to said liquid crystal dropping method is diminished through the control of the sprawling speed of the liquid crystal between said two pieces of the substrates by means of controlling the bonding speed thereof.

[Claim 2] The method for producing liquid crystal panel according to Claim 1, wherein said liquid crystal that is sandwiched between said two pieces of substrates are held at a temperature equal to or above the transparent point of said liquid crystal.

## [Detailed Description of the Invention]

[0001]

## [Technical Field of the Invention]

The present invention relates to a method for producing a liquid crystal panel, and more particularly to the uniform display in the liquid crystal.

[0002]

## [Description of the Related Art]

A liquid crystal display device is a display device in which the initial orientation direction of the liquid crystal is changed to a different orientation state through the effect that utilizes an anisotropy of said liquid crystal and the changes in the optical characteristics resulting therefrom are used. With an aim to making a display device in which in comparison to the conventional display device, driving at a low voltage is possible, and which is suitable for the large scale integration (LSI) driving and is a low power consumption type, and which is possible to make it thin and light weight, the display device is recently being developed and commercialized with an aim to mount it onto an office automation (OA) apparatus by means of incorporating a wide screen and large capacities.

[0003]

Presently, a dominant display device is a super twisted nematic (STN) type display device that is a passive matrix type and uses the changes in the arrangement state due to the application of an electric field onto the liquid crystal, in other words, the changes in electro-optical characteristics. The STN type display device is followed by active matrix type thin film transistor (TFT) type display device. The liquid crystal display device is a sandwich type where the liquid crystal is sandwiched between two

pieces of glass substrates that forms transparent electrode films. A polymer thin film for orienting the liquid crystal is formed onto the transparent electrode films. In case of the STN type display device, the cell thickness between two pieces of substrates is about 5 to 7 microns, and through the rubbing treatment onto the polymer thin film, the orientation of the liquid crystal is controlled such that about 3 to 8 degrees of pre-tilt angle is obtained. The STN type display device uses a bi-refrangent characteristics of the liquid crystal and the optical rotatory power of light. Because it thus is possible to obtain a steep and sharp critical value characteristics by means of changing the orientation direction of the liquid crystal between the two pieces of substrates by 180 to 270 degrees, about 0.05 to 0.1 microns of cell thickness are required in the STN type display device.

[0004]

The optical characteristics of the liquid crystal is obtained by the bi-refrangent characteristics and an dielectric anisotropy and the like that the liquid crystal molecule have. Besides, the optical characteristics are changed by the adjustment of the composition of the liquid crystal and the ration of the composition as well as including viscosities, elastic coefficients. Many kinds of liquid crystal materials are being developed and a desired

characteristics can be obtained by mixing these kinds of materials.

[0005]

Conventionally, a desired liquid crystal having several kinds of liquid crystal materials mixed therewith is sandwiched by means of the liquid crystal dropping method that is disclosed in Japanese Unexamined Patent Publication No. S63-179328, and a vacuum injection method. The liquid crystal dropping method disperses a spacer onto one of the glass substrates and drops a liquid crystal that is prepared in several number of syringes onto the other of the glass substrates with a constant pulse speed.

[0006]

[Problems to be Solved by the Invention]

Presently, in case where the liquid crystal panel is produced by means of the liquid crystal dropping method, in order to sandwich the liquid crystal, the liquid crystal is dropped onto one of the two pieces of glass substrate having the orientation treatments thereon, and the one substrate and the other substrate which pairs the one substrate are bonded at a vacuum atmosphere and then is leaked therefrom, thereby producing a liquid crystal panel. However, the speed of bonding the two pieces of substrates depends on the natural drop speed of the substrate and the outer pressure of the leaking from the vacuum atmosphere, but the

adjustment on the bonding speed was not particularly performed.

[0007]

In the meantime, the impurities that result from the atmosphere at the time of producing the liquid crystal panel are present on the substrate and in the liquid crystal before the substrates are bonded. If the impurities are melt in the liquid crystal or are dispersed, a density distribution of the impurities are occurred on the substrates when the liquid crystal is sprawled. At this time, the density distribution of the impurities are more outstanding by performing the dispersion operation of the liquid crystals that are dropped onto the substrates compulsively or sharply.

[0008]

Such chromatographic phenomenon causes the changes in the pre-tilt angle of the orientation film and the forming of the electric double layer in the liquid crystal panel surface and by the changes in the critical value resulting therefrom generates display unevenness in the liquid crystal panel surface, which is problematic. This chromatographic phenomenon depends on the quantities of impurities in the liquid crystal or on the substrates, the solubility in the liquid crystal, and the absorbing ability of the substrate surface, and further depends on the dispersion speed and the

flowing direction of the liquid crystal.

[0009]

The present invention have been made in consideration of above mentioned problems and have an object to provide a method for producing liquid crystal panel in which in the process of sandwiching a liquid crystal between two pieces of substrates, by controlling outer stress being applied onto the liquid crystal and the dispersion speed of the liquid crystal onto the substrates, the occurrence of the unequal display in a panel surface that is caused by the influence of various kinds of impurities existing in an atmosphere for producing a liquid crystal panel is prevented.

[0010]

[Means for Solving the Problems]

In order to accomplish the above-mentioned objects, the present invention provides a method for producing liquid crystal panel in which the liquid crystal panel is made by sandwiching a liquid crystal between two pieces of substrates by means of a liquid crystal dropping method, wherein the electrode patterns of the two pieces of substrates are subjected to an orientation treatment, wherein in the bonding process of the substrates is characterizing: the occurrence of the unequal display that are related to said liquid crystal dropping method is diminished through the control of the sprawling speed of the

liquid crystal between said two pieces of the substrates by means of controlling the bonding speed thereof.

[0011]

[Operation]

In the liquid crystal panel of the present invention, by using viscous fluid which has chemical resistance and is not chemically changed before and after producing the panel, the characteristics of the liquid crystal can be suppressed from being deteriorated and thus the reliability of the display characteristics of the liquid crystal panel is enhanced.

[0012]

In addition to this, when the liquid crystal is sandwiched between substrates that are bonded at temperature equal to or above the transparent point of the liquid crystal, the solubility to the liquid crystal is increased. In other words, the influence onto the unstableness of the liquid crystal's molecule arrangement that is resulting from the case where the impurities are present in the liquid crystal, is diminished, and therefore even if an excessive outer stress is applied onto the liquid crystal at the time of the liquid crystal's dispersion, the impurities in the liquid crystal are not likely to be separated or distributed.

[0013]

As a result of this, it is possible to suppress the



unevenness of the density distribution of the impurities on the substrates by means of dispersing the liquid crystal sufficiently smooth onto the substrates, and to prevent the display unevenness of the panel, which facilitates the uniformed display quality. In addition, by means of sandwiching the liquid crystal equal to or above the transparent point of the liquid crystal, it is possible to further increase the effect that results from dispersing the liquid crystal sufficiently smooth onto the substrates.

[0014]

[Embodiments]

Fig. 1 is a process diagram that illustrates the method for producing the liquid crystal panel in accordance with first and second embodiments.

[0015]

(First Embodiment)

First, as shown in Fig. 1-(1), transparent electrode patterns 3 and 4 are provided respectively onto the glass substrates 1 and 2. By means of flexo print method, an orientation film 6 (polyimide orientation film) is formed onto the substrates 1 and 2, which is then cured and is subjected to the rubbing treatment onto the surface thereof, and thus the orientation film 6 has an orientation characteristic. At this time, an orientation treatment is subjected between the substrates 1 and 2 in a direction

where the molecule of the liquid crystal 8 as shown in Fig. 3, which will be explained later, is tilted by 240 degrees, such that a spacer 7 of for example 7.0 microns is uniformly dispersed onto the glass substrate 1 as shown in Fig. 3 that will be explained later.

[0016]

Then, after placing the other glass substrate 2 on the dropping stage 10, the liquid crystal 8 containing chiral materials that are absorbed in three glass syringe accommodated in the dropping syringe 9 is dropped onto the glass substrate 2. After making a sealing material 5, as shown in Figs. 2 and 3 that will be explained later, to contain a spacer 7 at a ration of 1.5 weights percent by using UV curing resins, the sealing material 5 is printed on the substrate having the spacer 7 dispersed thereon by means of screen print methods.

[0017]

Next, as shown in Fig. 1-(2), by means of a vertically movable pin 12, the glass substrate 1 is held on the substrate bonding stage 11 at 10 millimeters above the glass substrate 2 and in parallel to the glass substrate 2. Thereafter, the vacuum chamber 14 is made to be vacuous by means of a vacuum pump 15. Finally, the vertically movable pin 12 is smoothly fallen down at a speed of 5 millimeters per second such that the glass substrates 1 and 2 are bonded

each other as shown in Fig. 1-(3).

[0018]

By making it possible to adjust the speed of bonding the glass substrates 1 and 2 sufficiently smooth, the dispersion speed of the liquid crystal 8 onto the substrates can be sufficiently smooth, and thus the process can be performed at temperature equal to or above the transparent point of the liquid crystal, which is the characteristics of the present invention.

[0019]

Next, as shown in Fig. 1-(3), by further falling the vertically movable pin 12, the bonded glass substrates are leaked and the sealing materials 5 as shown in Figs. 2 and 3 are cured by irradiating UV light. As a result of this, the liquid crystal panel can be produced as shown in the plan view of Fig. 2 and the sectional view of Fig. 3.

[0020]

Here, in Fig. 2 and Fig. 3, a reference number 1 denotes the glass substrate having a segment electrode 3 provided thereon, a reference number 2 denotes the glass substrate having a common electrode 4. On the other hand, in Fig. 1 the segment electrode 3 and the common electrode 4 are merely referred to the transparent electrode patterns 3 and 4 in together. The reference number 5 denotes sealing materials using UV curing resin which seal around the liquid

crystal 8 containing the spacer 7 as shown in Fig. 3. The reference number 6 denotes the orientation film provided onto the segment electrode 3 and the common electrode 4 on the glass substrates 1 and 2.

[0021]

After applying static waveforms onto the liquid crystal panel as shown in Fig. 2 and Fig. 3, the liquid crystal panel was tested by turning on and off the panel. The test result showed that the display unevenness depending on the liquid crystal's dropping position was scarce and that the difference of threshold voltages, where the transmittance becomes 10 percents of the maximum transmittance, at between the dropping position and the neighboring position were equal to or below 10 millivolt.

[0022]

(Second Embodiment)

A heater 13 is provided beneath the substrate bonding stage 11 in Fig. 1-(2) of the first embodiment. The surface temperature of the stage 11 is made equal to or above the transparent point of the dropping liquid crystal 8. Thereafter, the same process was done as that of the first embodiment. The result showed that the display unevenness was not found and the difference of threshold voltages at between the dropping position and the neighboring position were not detected.

[0023]

(First Comparative Embodiment)

The glass substrate 1 was naturally fallen at a position 10 millimeters above the glass substrate and a test was performed like in the first embodiment. The result showed that the display unevenness depending on the liquid crystal's dropping position was founded and that the difference of threshold voltages at between the dropping position and the neighboring position were about 30 millivolt.

[0024]

[Effect of the Invention]

As described above in detail, in the method for producing the liquid crystal panel in accordance with the present invention, by means of making the speed of bonding liquid crystal panel's substrates sufficiently slow, and in some occasions by means of performing the bonding process at temperature equal to or above the transparent point of the liquid crystal, it is possible to produce a uniform liquid crystal panel which does not show display unevenness in the panel surface which were generated in the conventional dropping method.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a process diagram that illustrates the method for producing a liquid crystal panel in accordance with first and second embodiments of the present invention.

[Fig. 2]

Fig. 2 is a plan view illustrating the liquid crystal panel produced by the method in accordance with the present invention.

[Fig. 3]

Fig. 3 is a sectional diagram illustrating the liquid crystal panel in Fig. 2.

[Reference Numerals]

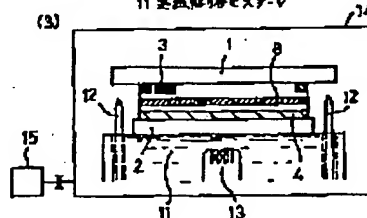
- 1: glass substrate at segment electrode side
- 2: glass substrate at common electrode side
- 3: segment electrode
- 4: common electrode
- 5: spacer containing UV curing resin seal materials
- 6: orientation film
- 7: spacer
- 8: liquid crystal
- 9: dropping syringe
- 10: dropping stage
- 11: substrate bonding stage

- 12: vertically movable pin
- 13: heater
- 14: vacuum chamber
- 15: vacuum pump

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101





## 【特許請求の範囲】

【請求項1】 電極パターン上に配向処理を施した2枚の基板間に、液晶滴下工法により液晶を挟持してなる液晶パネルにおける基板貼り合わせ工程において、その貼り合わせ速度を調整することにより前記2枚の基板間に液晶が伸び広がる速度を調節し、液晶滴下工法に係わる表示ムラを軽減することを特徴とする液晶パネルの製造法。

【請求項2】 液晶の透明点以上の温度で2枚の基板間に液晶を挟持することを特徴とする請求項1記載の液晶パネルの製造法。

## 【発明の詳細な説明】

## 【0001】

【産業上の利用分野】本発明は液晶パネルの製造法に関し、特に液晶パネルの表示均一化に関するものである。

## 【0002】

【従来の技術】液晶ディスプレイ装置は、液晶の初期配向方位を液晶の異方性を利用した作用により他の配向状態に変化させ、それに伴う光学的特性の変化を利用した表示装置である。従来の表示装置に比べ低電圧駆動が可能であり、LSI駆動に適すること、低電力消費タイプであること、薄型、軽量化が可能であること等から、近年、大画面化、大容量化によりOA機器への搭載を目指し、開発、商品化されつつある。

【0003】現在、液晶の電場印加による配列状態の変化、即ち電気光学特性を利用した単純マトリックス方式のスーパーツイステッドネマティック(STN)形ディスプレイ装置が主体をなし、アクティブマトリックス方式の薄膜トランジスタ(TFT)形ディスプレイ装置がこれに続く。液晶ディスプレイ装置は透明電極膜を形成した2枚のガラス基板間に液晶を挟んだサンドイッチタイプであり、透明電極膜上には液晶を配向させるための高分子薄膜を形成させる。STN形ディスプレイ装置の場合、2枚の基板間のセル厚は5~7 $\mu\text{m}$ 程度であり、高分子薄膜上をラビングすることで液晶の配向を制御し、3~8°程度のプレチルト角(基板と液晶分子のなす起き上がり角)を持たせる。STN形ディスプレイ装置は液晶の複屈折性と光の旋光性を利用したものであり、2枚の基板間で液晶の配向方向を180°~270°捻ることで著しく急峻なしきい値特性を得ることを可能にしているため、セル厚は0.05~0.1 $\mu\text{m}$ の精度を必要とする。

【0004】液晶パネルの光学特性は、液晶分子の持つ複屈折性、誘電率異方性等により得られる。その他粘性、弾性定数等を含め用いる液晶材料の組成、その成分比の調整により液晶パネルの光学特性は変化する。現在様々な液晶材料が開発されており、液晶材料の調合により望みの特性を得ることが可能である。

【0005】通常、数種類以上の液晶分子を混ぜ合わせた所望の液晶を、滴下法(特開昭63-179328号公報)あるいは真空注入法により2枚の基板間に挟持する。液晶滴

下法は一方のガラス基板上にスパーサーを分散させ、数本のシリンジ内に用意した液晶を他方のガラス基板上に一定パルスで滴下する工法である。

## 【0006】

【発明が解決しようとする課題】現在、液晶滴下法により液晶パネルを作製する場合、液晶を挟持するために配向処理した2枚の基板の一方の基板に液晶を滴下し、それと対をなす他方の基板を真空雰囲気下で貼り合わせた後リークすることにより液晶パネルを作製する。しかし2枚の基板を貼り合わせる速度は、基板の自然落下速度、及び真空状態からのリークによる外圧に依存しており特に貼り合わせ速度の調整は行われていなかった。

【0007】ところで貼り合わせ前の基板上及び液晶中には、パネル製造時の雰囲気に応じた不純物が存在する。この不純物が液晶中に溶解、あるいは分散している場合、液晶が伸び広がるときに基板上で不純物の濃度分布が生ずる。このとき基板上に滴下した液晶の広がりを強制的かつ急激に行うことにより不純物の濃度分布はより顕著となる。

【0008】このようなクロマト現象は液晶パネル面内で配向膜のプレチルト変化、電気二重層の形成をもたらし、それによるしきい値変化により液晶パネル面内で表示ムラが発生するという問題があった。このクロマト現象は液晶中または基板上の不純物量、液晶への溶解度、基板表面の吸着能に左右される他、液晶の広がり速度、流れ方向にも影響を受ける。

【0009】本発明は、このような点に鑑み、2枚の基板間に液晶を挟持する過程において、液晶に加わる外部応力、基板上での液晶の広がり速度を制御することにより液晶パネル面内で偏った不純物濃度分布が発生することを防止し、液晶パネル面内で表示が均一な液晶パネルが得られる製造法を提供することを目的とする。

## 【0010】

【課題を解決するための手段】本発明は上記目的を達成するため、電極パターン上に配向処理を施した2枚の基板間に、液晶滴下工法により液晶を挟持してなる液晶パネルにおける基板貼り合わせ工程において、その貼り合わせ速度を調整することにより前記2枚の基板間に液晶が伸び広がる速度を調節し、液晶滴下工法に係わる表示ムラを軽減することを特徴とする。

## 【0011】

【作用】本発明によれば、液晶の広がり速度を十分緩やかに調整することにより液晶中に溶解、分散した不純物は急激な外部エネルギー、具体的には基板と垂直方向の押圧による基板面に平行な応力を受けることなく、マクロ的には液晶中に均一に存在したまま基板上に広がる。また液晶の広がり速度が遅くなることで基板上に存在する不純物が液晶から受けるエネルギーも小さくなり、物理吸着レベルでも液晶の流れに影響されことなく基板上の既存の位置に残存し不純物の濃度分布に関与しな

い。

【0012】また液晶の透明点以上の温度で基板を貼り合わせて液晶を挟持する場合、液晶中への不純物の溶解性が高まる。即ち液晶中に不純物が存在した場合にもたらず分子配列の不安定性に対する影響が弱まり、液晶が広がるときに無理な外部応力を受けても液晶中の不純物が分離、あるいは偏在しにくい。

【0013】従って液晶を基板上で十分緩やかに広げることにより基板上での不純物濃度分布の偏りを抑制し、パネルの表示ムラを防止し表示品位の均一化を図るものである。なお、液晶の透明点以上の温度で液晶を挟持することにより液晶を基板上で十分緩やかに広げることによる効果が一層高まるものである。

【0014】

【実施例】図1は本発明の第1および第2の実施例における液晶パネルの製造方法を示す工程図である。

【0015】（実施例1）まず、図1(1)に示すように、透明電極パターン3、4を設けたそれぞれのガラス基板1、2上にフレキシ印刷法により配向膜6（ポリイミド配向膜）を形成、熱硬化した後、表面をラビングすることにより配向性を持たせる。このとき対向基板間で後述する図3に示す液晶8の分子が240°捻れる方向に配向処理を施し、ガラス基板1には後述する図3に示す、例えば7.0μmのスペーサー7を均一に分散させる。

【0016】次に滴下ステージ10上に他方のガラス基板2を配置し、そのガラス基板2上に滴下シリンジ9に収められた3本のガラスシリンジ内に吸引したカイラル入り液晶8（ネマティック液晶）を滴下する。後述する図2、図3に示すシール剤5にはUV硬化樹脂を使用し、予めスペーサー7を1.5wt%の割合で含有させた後、スクリーン印刷によりスペーサー7を分散させた基板に印刷する。

【0017】次に図1(2)に示すように基板貼り合せステージ11上でガラス基板2の上方10mmの位置にガラス基板1をガラス基板2と平行になるように上下可動ピン12で保持した後、真空ポンプ15に真空チャンバー14内を真空に引く。その後、上下可動ピン12を5mm/secの速度で緩やかに降下させ、ガラス基板1、2を図1(3)に示すように貼り合わせる。

【0018】上記ガラス基板1、2を貼り合わせる場合の貼り合わせ速度を十分緩やかに調整可能とすることにより、基板上での液晶8の広がり速度を十分緩やかなものとし、このプロセスを液晶の透明点以上で行うことを特徴とするものである。

【0019】次に図1(3)に示すように上下可動ピン12を更に降下させ、貼り合わせたガラス基板1、2をリークし、後述する図2、図3に示すシール剤5をUV照射して硬化する。これにより、図2の平面図、図3の断面

図に示すような液晶パネルを作製できる。

【0020】ここで、図2および図3において、1はセグメント電極3が設けられたガラス基板、2はコモン電極4が設けられたガラス基板であり、図1ではセグメント電極3、コモン電極4を単に透明電極パターン3、4と呼んでいる。5はUV硬化樹脂を使用したシール剤であって、図3に示すようにスペーサー7が入った液晶8の周囲をシールする。6は前記ガラス基板1、2上のセグメント電極3、コモン電極4上に設けられた配向膜である。

【0021】上記図2および図3に示す液晶パネルにスタティック波形を印加し液晶パネルを点灯評価した結果、液晶滴下位置に依存した表示ムラは殆どなく、滴下位置とその周囲とのしきい値電圧（最大透過率を100%としたときの透過率10%となる電圧）差としては10mV以下であった。

【0022】（実施例2）実施例1における図1(2)の基板貼り合せステージ11の下方に加熱ヒーター13を設けステージ表面温度を滴下する液晶8の透明点以上の温度とした後、実施例1と同様の作業を行った。その結果、表示ムラは全く発生せず、滴下位置とその周囲でしきい値電圧差としても検出されなかった。

【0023】（比較例1）ガラス基板1をガラス基板2の上方10mmの位置から自然落下し、実施例1と同様の評価を行ったところ、滴下位置に依存した表示ムラが発生し、滴下位置とその周囲で30mV程度のしきい値差が確認された。

【0024】

【発明の効果】以上説明したように本発明の液晶パネルの製造方法は、液晶パネルの基板貼り合わせ速度を十分に遅くし、更に場合によっては液晶の透明点以上の温度で貼り合わせを行うことにより、従来の滴下工法で発生するようなパネル面内の表示ムラのない均一な液晶パネルを作製することが可能である。

【図面の簡単な説明】

【図1】本発明の第1、第2の実施例における液晶パネルの製造方法を示す工程図である。

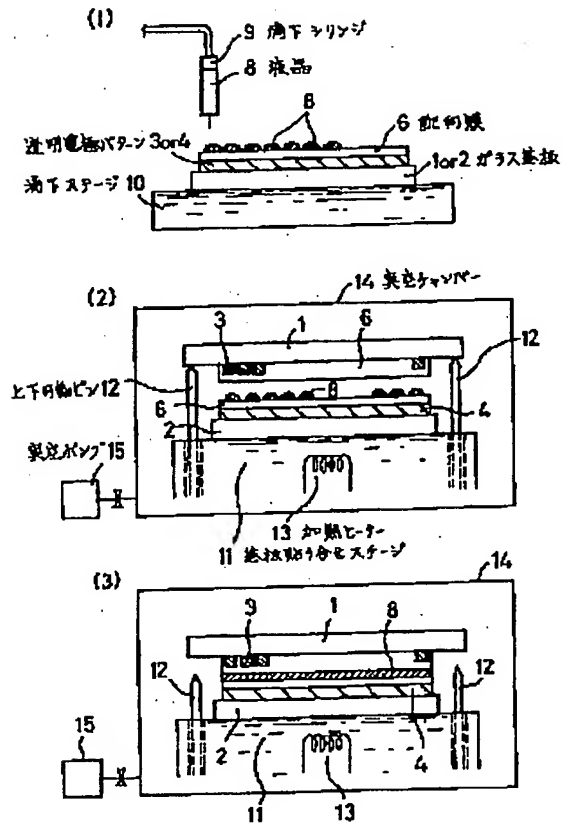
【図2】本発明の方法で製造された液晶パネルの平面図である。

【図3】図2の液晶パネルの断面図である。

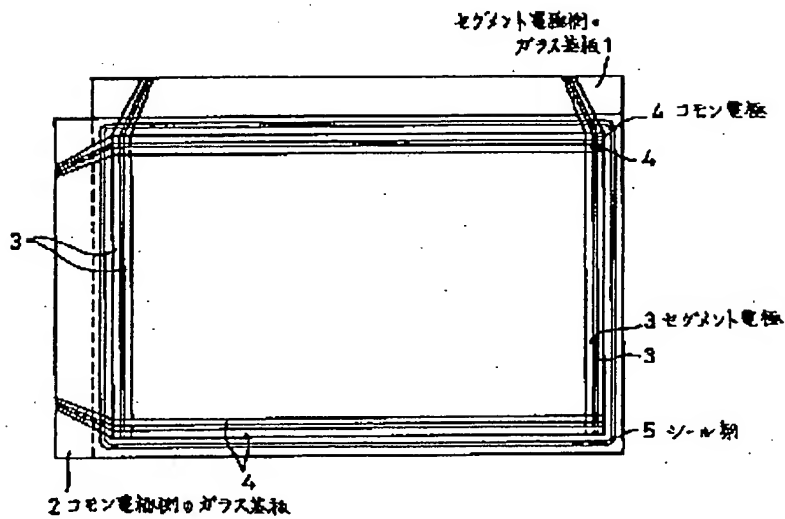
【符号の説明】

1…セグメント電極側のガラス基板、2…コモン電極側のガラス基板、3…セグメント電極、4…コモン電極、5…スペーサー入りUV硬化樹脂シール剤、6…配向膜、7…スペーサー、8…液晶、9…滴下シリンジ、10…滴下ステージ、11…基板貼り合せステージ、12…上下可動ピン、13…加熱ヒーター、14…真空チャンバー、15…真空ポンプ。

【図 1】



【図 2】



【図 3】

